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Studies on Resource Use Efficiency of Minor Millets in Northern Karnataka

A D Naik, L B Kunnal*, N M Kerur, Anand Naik and N Ashoka**

Department of Agribusiness Management, *Department of Agricultural Economics,
University of Agricultural Sciences, Dharwad - 580 005, Karnataka, India
**Department of SSAC, University of Agricultural Science, Raichur - 584 101, Karnataka, India
e-mail: adnaik.abm@gmail.com

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ABSTRACT

The present study is an effort to study resource use efficiency of minor millets in the northern parts of Karnataka. The functional analysis revealed that bullock labour, farmyard manure and seeds were under used whereas human labour and fertilizer were over utilized in little millet (savi) production. Except land all the other inputs were over utilized in fox tail millet (navane) production. Thus there is need to reallocate the expenditure on different resources in savi and navane production so as to maximize the profits in the farm. Very few sample farmers of savi and navane were found to operate at high technical efficiency rating of above 90 per cent. There exists a vast scope for improving savi and navane productivity in the study area by increasing the technical efficiency without the use of additional quantity of resources. The findings of the study indicated the lower economic efficiency of both savi (25.82%) and navane (22.23%) sample farmers. Thus, improvement in economic efficiency through concerted efforts on part of the farm management personnel and extension agencies is the felt need for improving the productivity of these crops and income levels at the farm level.

Key words: Efficiency, Resources, Little millet, Foxtail millet, Technical efficiency, Economic efficiency

In Karnataka, small millets are cultivated on an area of 1.25 million ha producing 1.54 million tonnes with a productivity of 1230 kg/ha. In the year 2010-11 foxtail millet (Navane) was cultivated in an area of 24508 hectare producing 5470 tonnes with productivity of 235 kg/ha. Foxtail millet is widely grown in Koppal, Bellary, Chitradurga and Belgaum districts of Karnataka (Nagaraj and Khan 1998). The reasons for limited utilization of millets are poor grain quality characteristics, such as rough texture, high fibre content, lack of gluten and typical flavor. The rather strong taste of millets is not generally preferred by persons with access to blander grains. Millets being small seeded contain large proportions of husk and bran requires dehusking and debraning prior to consumption. Despite, their nutritional superiority utilization of millets is restricted due to non-availability of refined and processed millets in ready to eat form. Hence, millets are confined to traditional consumers and to the people of lower strata. A majority of the millet production (80%) although is used for human food, it is also used for feeding cage birds. Minor millets are fair sources of protein and are limiting in lysine. Millet flour can be replaced for rice flour in the preparation of chakkali, dosa and idli. The cultivation of foxtail millet (navane) and little millet (savi) is more seen in Madhya Pradesh, Tamil Nadu, Karnataka and Orissa. Presently, small millets are cultivated in areas where they produce a more dependable harvest compared to any other crop (Verma 2002). This has been largely responsible for their continued presence and cultivation in many parts of the world. These crops provide good nutrition and compare very well with rice or wheat. Further, small millets are superior in protective nutrients such as vitamins, minerals, dietary fibre, essential amino acids and phytochemicals. Presently, the problem appears to be one, increasing productivity and profits in foxtail millet and little millet cultivation and improving the marketing procedure. Economic studies on these underutilized millets production carried out in India have not provided sufficient guidelines on cost economics and production efficiency. For rationalization of resource use, the information on the structure of costs and returns is necessary. It is worth noting that the economic studies on millets, conducted so for in India, are few and have not analyzed the detailed aspects of resource use efficiency.

MATERIALS AND METHODS

The present investigation is entirely based on primary and secondary data. The study was conducted in the northern part of Karnataka state with the help of well structured questionnaire during 2009-10. Multistage sampling technique was employed in the selection of farmers for the study based on the production of little millets and foxtail millet in the state during *kharif* season. Dharwad and Haveri districts were selected as they had highest share in production of little millet. Bellary and Koppal districts were selected because they were having highest share in the production of foxtail millet in North Karnataka. Thus, for each crop two districts were selected, from each district three villages having highest area under the crop were selected and from each village ten farmers growing respective crop were selected randomly and thus the total sample size for the study was 120 constituting 60 little millet and 60 foxtail millet growers. The sample farmers were interviewed personally by using schedule prepared for the purpose. Data on some selected socio economic characteristics of the farmers, land holdings, cropping pattern, inventory of implements and machinery were collected. The data on quantity and value of various inputs used and the yield obtained in case of underutilized millets were collected. In order to analyze collected data functional analysis was carried out. The resource use efficiency in savi and navane production was studied by fitting the Cobb-Douglas type production functions to the farm level data. The specification of the equation is as follows:

$$Y = a X_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} e^{u}$$

In logarithmic form, it assumed a log linear equation as under:

$$\log Y = \log a + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + b_6 \log X_6 + u \log e$$

Where, Y = Output (Quintals)

X_1 = Land area (hectare)

X_2 = Human labour (man days)

X_3 = Bullock labour (pair days)

X_4 = FYM (cart loads)

X_5 = Seeds (Kg)

X_6 = Fertilizers (Kgs)

a = Constant

u = Random variable

b_1 to b_6 elasticity coefficients of respective inputs

Specification of variables

Dependent variables

i) Output of savi/navane (Y): This was defined as the yield of savi/navane produced per farm in quintal

Independent variables

i) Land area (X_1): This input was measured in terms of net area under the crop in hectares.

ii) Human labour (man days) X_2: This input was expressed in terms of total man days per farm in the production of savi/navane.

iii) Bullock labour (pair days) X_3: This input was expressed in terms of total pair days per farm in the production. iv) Seeds (Kg) X_4: This refers to seeds used per farm in the savi/navane production.

v) Farm yard manure (cart loads) X_5: This input was expressed in terms of cart loads applied to the farm in savi/navane production.

vi) Value of fertilizers (Rs) X_6: This was defined as quantity of fertilizers used in savi/navane production.

Estimation of marginal products and marginal value products

The marginal products were calculated at the geometric mean levels of the variables by using the following formula:

Marginal product of input = bi $\dfrac{\bar{Y}}{\bar{X}_i}$

Where, $\bar{Y}$ = Geometric mean of out put

$\bar{X}_i$ = Geometric mean of i[th] independent variable

bi = The regression coefficient of i[th] independent variable

The marginal value product of each resource was calculated by multiplying the marginal product of the resource by the price of the product.

Technical, allocative and economic efficiency

A. Technical efficiency analysis

It refers to the ability to produce the greatest possible output from a given set of inputs. A producer is said to be technically efficient when no matter what input combination is used, the maximum output is produced. Overall technical efficiency can be expressed as:

$$\text{Over all TE} = \frac{\text{Average output}}{\text{Maximum output}}$$

According to Aigner, Lovell and Schmidt (1977) and Meeusen and Van den Broeck (1977), where the error term is composed of two parts, the stochastic frontier production function is defined by:

$$Y_i = f(Xi, \beta) \exp(V_i - U_i) \quad i = 1, 2, \ldots N \ \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where, Yi = Observed output

X_i = the actual input vector

β = the vector of production function parameters

exp (Vi-Ui) $= e^{Vi-Ui}$

V_i = is two sided, symmetric component, normally distributed random error ($V_i \sim N(0, б^2v)$ which permits random variation in output resulting from factors outside the control of the farm like weather, disease etc.

U_i = the non-negative one-sided error term. It is one-sided efficiency component with a half normal distribution [U_i – N (0, $б^2u$,)]. It represents deviations from maximum potential output attributable to technical inefficiency. Technical efficiency of an individual firm can be expressed as:

$$TE_i = Y_i/Y_i^*$$

Where, Y_i = the observed output

Y_i^* = the corresponding frontier output

lt can be rewritten as:

$$Tei = f(X_i ; \beta) \exp(V_i-U_i) / f(X_i ; \beta) \exp(V_i) \quad \ldots\ldots. (2)$$

$$= \exp(-U) \quad \ldots\ldots. (3)$$

In order to empirically measure technical efficiency, the frontier production function was estimated using maximum likelihood (ML) procedure due to the specific distributional assumptions of V (random component) and U (inefficiency component) which provides sufficient information to calculate a conditional mean for U. The resulting log-likelihood function is written as:

Where,

$$\text{Ln } L = 1\text{n } (2/\pi) - N1n\sigma + \sum_{i=1}^{N} \ln [1 - F(e_i \lambda\sigma^{-1})] - 1/2\sigma^2 \sum_{i=1}^{N} e_i^2 \quad \ldots (4)$$

F(.) is the cumulative distribution of the standard normal density function evaluated at $e \lambda / \sigma$:

$\sigma^2 = \sigma_u^2 + \sigma_v^2$ (Variance of E)

$\lambda = \sigma_u / \sigma_v$ (ratio of two standard errors)

or $= \sigma_u^2 / \sigma^2 \quad 0 \leq \lambda \leq 1$

The maximum likelihood estimation used in the study yields estimations for β and λ or Y.

The mean of this distribution can be used as a point estimate of inefficiency error (U_i) given the total error (U_i+V_i) by the following formula:

Where,

$$E (U_i / U_i + V_i) = \left[\frac{\sigma_u \sigma_v}{\sigma} \left(\frac{\phi(.)}{1-\phi} \right) \left(\frac{u_i + v_i}{\sigma} \right) \frac{\gamma}{1-\gamma} \quad ½ \right]$$

$\gamma = \sigma_u^2 / \sigma^2$

$\sigma^2 = \sigma_u^2 + \sigma_v^2$

Φ (.) and Φ are standard normal density and cumulative distribution functions evaluated at [(U+V) σ] and $[(\gamma \Delta J\text{-}\gamma)^{1/2}]$, respectively.

The modified log-linear Cobb-Douglas stochastic frontier model estimated in the study is specified as:

In (Yi) = bo + b1 ln (A) = b2 ln(S) + b3 ln (FR) + b4 ln (LB) + B5ln (B) + b6 ln (FM) + Vi- Ui ……………………........ (6)

Where,

The subscript 'i' indicates the i^{th} farmer in the sample (i = l, 2, ... 40)

In represents the natural logarithm (i e logarithm to base e)

Y = the output of sorghum in quintals

bi = unknown parameters to be estimated

A = area under sorghum in hectares

S = Amount of seed used in kgs

FR = Amount of fertilizer used in kgs

LB = human labour spent in the operations of sorghum production in man days

B = Bullock labour used in pair days

FM = Amount of farmyard manure applied in cartloads

V_is are assumed to be symmetric and identically distributed random errors having N (0, σ^2v) distribution.

U_is are non-negative random variables, called technical inefficiency effects, which are assumed to be independently distributed such that U_i is defined by the truncation (at zero) of the normal distribution with mean (μ_i) and variance (σ^2)

For the sake of completeness, the parameters of the deterministic Cobb-Douglas production function were also estimated using ordinary ' least squares (OLS) techniques.

B. Allocative efficiency

Farm specific allocative efficiency (AEij) in the use of variable input (i) is:

AE_{ij} = MGRj/OGRij …………..……………………...... (7)

OGR_{ij} = Output at the optimum level of the i^{th} input, with all other inputs remaining at the level at which they were used by the farmer.

MGR_j = Maximum possible output

Farm-specific optimum input level is calculated by equating MVP of an input with its price.

The allocative efficiency (AEij) of all inputs on the j^{th} farm is estimated to be:

Overall $AE_j = MGR_j / OGR_j$ .... (8)

Where, OGR_j = the j^{th} farmer's output at the optimum level of all variable inputs.

In order to determine whether a particular resource is used optimally, MVP and opportunity cost (factor cost) of one unit of that resource was compared:

$$\text{MVP of } X_i = b_i \frac{\bar{Y}}{\bar{X}_i} \text{ Py}$$

Where, b_i = elasticity of production (regression coefficient) of i^{th} input

$\bar{Y}$ = geometric mean of output

$\bar{X}_i$ = Geometric mean of j^{th} input

Py = Price of the product

The comparisons of ratios (MVP/MFC) for judging efficiencies are:

MVP/MFC > l indicated under use of resources

MVP/MFC = l optimum use of resources (allocatively efficient)

MVP/MFC < l indicated excess use of resources.

C. Economic efficiency

Farm specific economic efficiency (EE_j) can be estimated using the following equation

$$EE_j = TE_j \text{ X } AE_j$$

Where,

TE_j = Farm specific technical efficiency of jth farmer

AE_j = Allocative efficiency of all inputs on the jth farm

Overall economic efficiency was computed using the following formula:

$$\text{Overall EE} = Y / Y^*$$

$\bar{Y}$ = Average output

Y* = output at the optimum level of all variable inputs

RESULTS AND DISCUSSION

Resource use efficiency in little millet (savi) production

The resource use efficiency analysis assumes greater importance in ascertaining whether production at farm level and in turn in the region could be increased profitably to an optimum level by making reallocation of existing resource use pattern. The Cobb-Douglass type of production function was fitted to the production and input use data in savi production. The results in production function estimates, geometric mean levels of inputs and output, marginal factor cost, marginal value product and profitability ratio (Table 1). The factors influencing production of little millet crop were identified through theoretical considerations and were investigated by constructing their linear scatter graphs against their crop yields. The log linear type of production functions were fitted selecting yield (kgs) as dependent variable. The independent variables included in the model were land (ha), human labour (man days), bullock labour (pair days), farmyard manure (cart loads), seeds (kgs) and fertilizers (kgs). It could be observed from the table that the co-efficient of multiple determination (R2) was 0.99. Thus, 99 per cent of variation in savi yield was explained by the six variables included in the model. These results are in line with Kumar *et al*. (2005). The estimated parameters of bullock labour (0.702), farmyard manure (0.393) and seeds (0.289) were positive and significant at one per cent probability level. Thus, the savi production was highly influenced by these three variables. Even though the regression co-efficient of land (0.082) was positive but fail to exert any significant influence on savi yield. The production elasticities of human labour (-0.788) and fertilizers (-0.018) were negative. The co-efficient of human labour was negative and significant at one per cent probability level. The marginal value products of various inputs were worked out using the equation- ($bi = Y/X_1$) presented in methodology chapter. The marginal value products of human labour (-92.841) and fertilizer (-1.206) were negative due to negative regression coefficients of these inputs. Land showed the highest marginal value product (555.36) followed by farmyard manure (435.43), bullock labour (332.73) and seeds (171.29). The marginal analysis revealed that land, bullock labour, farmyard manure and seeds were underutilized. On the other hand, labour and fertilizers were over used on savi farms. The results of the (Cobb-Douglass type) production function analysis of savi production showed that the co-efficient of multiple determination (R^2) was 0.99, implying 99 per cent of variation in savi production was explained by the six variables included in the model. The estimated coefficients of parameters of bullock labour (0.70), FYM (0.39) and seeds (0.29) were positive and significant at one per cent probability level. Thus, the savi production was highly influenced by these three variables. However, land (0.08) coefficient was failed to exert any significant influence on savi production, as it was statistically non-significant. Human labour and fertilizers were excessively used in savi production, as indicated by their negative elasticity coefficients. Thus there is need to reduce the expenditure on these inputs. The analysis of marginal value products of various inputs indicated that it was negative for human labour (-92.84) and fertilizer (-1.20), which was due to over use of these inputs. Land showed the highest marginal value product followed by farm yard manure (435.43), bullock labour (332.73) and seeds (171.29). Thus there is scope to increase area under savi production in combination with increased use of bullock labour and higher seed rate, as farmers are also using seeds less than the recommended dose of seeds. Land, bullock labour, farm yard manure and seeds were over utilized in the production of savi where as human labour and fertilizers were underutilized. By optimum utilization of these resources the profits can be increased.

Table 1 Resource use efficiency in little millet (savi) cultivation (Per farm)

Particulars	Intercept	Land (ha)	Human labour (Man days)	Bullock labour (Pair days)	FYM (Cart loads)	Seeds (kg)	Fertilizers (kg)	R^2	Adjusted R^2
Marginal factor cost (Rs)		1000	40	150	110	9.2	10		
Geometric mean		0.431	24.652	6.122	2.620	4.891	44.130		
Regression coefficients	1.968** (0.428)	0.082 (0.087)	-0.788** (0.159)	0.702** (0.127)	0.393** (0.037)	0.289** (0.046)	-0.018 (0.045)	0.991	0.990
Marginal value product (Rs)		555.365	-92.841	332.726	435.434	171.294	-1.206		
MVP/MFC ratio		0.555	-2.321	2.218	3.958	18.619	-0.121		

Figures in parentheses indicate standard error of respective regression coefficients; **Significant at 0.01 probability level

Table 2 Resource use efficiency in foxtail millet (navane) cultivation (Per farm)

Particulars	Intercept	Land (ha)	Human labour (Man days)	Bullock labour (Pair days)	FYM (Cart loads)	Seeds (kg)	Fertilizers (kg)	R^2	Adjusted R^2
Marginal factor cost (Rs)		1000	40	150	110	10.2	10		
Geometric mean		0.510	26.007	7.993	12.445	5.062	45.489		
Regression coefficients	1.556 (0.441)	1.061** (0.194)	0.091 (0.102)	-0.312** (0.061)	0.102** (0.039)	-0.227* (0.135)	0.111** (0.028)	0.975	0.972
Marginal value product (Rs)		6347.962	10.632	-119.026	24.917	-136.558	7.449		
MVP/MFC ratio		6.348	0.266	-0.794	0.227	-13.388	0.745		

Figures in parentheses indicate standard error of respective regression coefficients; **Significant at 0.01 probability level

Resource use efficiency in foxtail (Navane) production

The regression analysis revealed that six independent variables viz, land, human labour, bullock labour, farmyard manure, seeds and fertilizers included in the model explained 97.5 per cent variation in foxtail (navane) production as indicated by the co-efficient of multiple determination (R^2) and was significant at one per cent probability. Unlike in the case of savi crop, the co-efficient of bullock labour (-0.312) and seeds (-0.227) were found to be negative and were significant at one per cent and ten per cent probability level, respectively. On the other hand production elasticity of land (1.06), farmyard manure (0.10) and fertilizers (0.11) were positive and significant at one per cent probability level (Table 2). Even though the production elasticity co-efficient of human labour (0.09) was positive but failed to exert any significant influence on navane yield. Similar results were found by Reddy and Sen (2004). In a study of technical efficiency of rice growers in Tamil Nadu almost similar results were reported by Mythili and Shanmugam (2000). It could be observed from the table that the marginal productivity of the land (6.34) was the highest followed by farmyard manure (0.22), human labour (0.22) and fertilizer (0.74). Use of additional one hectare of land would result in Rs.6347.96 increase in gross returns in navane production. Similarly, use of additional unit of human labour, farmyard manure and fertilizers would result in additional returns of Rs. 10.65, Rs. 24.92 and Rs. 7.45, respectively. To analyze the scope for intensification of resources use in navane production, profitability ratios were calculated. The analysis showed that MVP: MFC ratio was less than unity for all the inputs except land indicated over utilization of these resources. Thus less than one and positive profitability ratio indicating that profit could be maximized by using less quantity of all these inputs. Resource use efficiency in navane revealed that six independent variables included in the model explained 97.5 per cent variation in navane production as indicated by the R^2 (0.98) and was significant at one per cent probability. The computed F value (344.39) implied a good fit of model.

The co-efficient of bullock labour (-0.312) and seeds (-0.227) were found to be negative and significant at one per cent and five per cent probability level, respectively. Land (1.061), farm yard manure (0.102), and fertilizers (0.111) showed positive production elasticity's and were significant at one per cent probability level. Even though the elasticity co-efficient of human labour (0.091) was positive but failed to exert any significant influence on navane yield. Thus there is need to reduce the expenditure on bullock labour and fertilizers. Nagaraj and Khan (1998) also reported similar results in case of resource use efficiency in various crops under different cropping system in Tungabhadra command area in Karnataka. It could be observed from the table that the marginal productivity of the land (6347.96) was the highest followed by farm yard manure (24.91), human labour (10.63) and fertilizer (7.45). Profitability ratio analysis showed that MVP: MFC ratio was less than unity for all the inputs except land, indicating their over utilization thus there is a need to reduce expenditure on these inputs.

Technical and allocative efficiency in crop (savi) production
Timmer's measure of technical efficiency of Savi

One of the major objectives of the study was to analyze technical, allocative and economic efficiency in savi and navane production in the study area. For this purpose, the popularly used Cobb-Douglas production function was fitted. The technical efficiency in savi production was worked out by using Timmer method. The average technical efficiency for savi production was 62.45. About 48 per cent of savi sample farmers were found to operate at technical efficiency rating less than 60 per cent. Nearly 22 and 15 per cent of the sample farmers belonged to the 61-70 and 71-80 per cent of technical efficiency rating group, respectively (Table 3). Relatively less i e only about eight and seven per cent of the savi sample farmers operated in the 81-90 per cent and more than 90 per cent of the technical efficiency rating group, respectively. The classical production function assumes that all the farmers are technically efficient. Efficiency would be relevant when it is studied in the context of the situation in which the farmer operates. Frontier production function is an approach where the efficiency is studied on a relative basis. The farmers in a particular area evaluated for their efficiency by comparing with the best in their peer group. This is done by shifting the intercept of the average Cobb-Douglas production function upwards to coincide with the most efficient farmer and the rest are compared with this, both in terms of output and input. Neelappa (2002) observed analogous results in case of technical and allocative efficiency of paddy production in TBP area in Karnataka. The production parameters of the estimated Cobb-Douglas production function presented in results chapter used to study the technical efficiency in savi production. The average technical efficiency was 62.45 per cent for savi sample farmers. Majority of the savi farmers were operating in the efficiency of less than 60 per cent followed by efficiency between 61 per cent and 70 per cent efficiency level. Only about eight and seven per cent of savi sample farmers were found to operate at high technical efficiency rating of 81-90 per cent and above 90 per cent, respectively. Hence, there is a vast scope for improving savi productivity in the study area by increasing technical inefficiency without using additional resources.

Table 3 Distribution of sample farmers according to the technical efficiency rating in savi production

Per cent of technical efficiency	Farmers	
	No.	Percent
<60%	29	48.33
61-70%	13	21.66
71-80%	9	15.00
81-90%	5	8.33
91% and above	4	6.66
Average technical efficiency (%)	62.45	

Timmer's measure of technical efficiency of Navane

For assessing the technical, allocative and economic efficiency in navane production in the study area again the Cobb-Douglas production function was used. The production parameters of the estimated Cobb-Douglas production function were used. Timmer method was used to work out the technical efficiency in navane production in the study area. The average technical efficiency level achieved by the navane sample farmers was 70.76 per cent (Table 4). It could be observed that the highest proportion (35.00%) of navane growing farmers operated between 61-70 per cent technical efficiency followed by less than 60 per cent technical efficiency group (31.66%), 71-80 per cent technical efficiency group (71.33%), 81-90 per cent technical efficiency group (10.00%) and only five per cent of the farmers achieved more than 90 per cent of technical efficiency in the study area. For estimating the technical efficiency in navane production the production parameters of the estimated Cobb-Douglas production function (Table 4) were used. The average technical efficiency of navane producing sample farmers was 70.67 per cent. Unlike savi production, majority of the navane sample farmers (21) were operating in the efficiency level between 61-70 per cent followed by 19 farmers operating in the efficiency range between 61 per cent and 70 per cent efficiency level, 11 farmers in 71-80 per cent technical efficiency level. Only 3 farmers of navane crop were found to operate at high technical efficiency rating of above 90 per cent. As in the case of savi production, here also there exists a vast scope for improving navane productivity in the study area by increasing the technical efficiency without the use of additional quantity of resources.

Table 4 Distribution of sample farmers according to the technical efficiency rating in navane production

Per cent of technical efficiency	Farmers	
	No.	Percent
<60%	19	31.66
61-70%	21	35.00
71-80%	11	18.33
81-90%	6	10.00
91%and above	3	5.00
Average technical efficiency (%)	70.67	

Kopp measure of technical efficiency of savi

The amounts of various resources that would have been required for the farmers to produce existing level of output at the highest level of technical efficiency were worked out and these levels of inputs are called as frontier level of input use. The frontier level of input use were compared with actual levels of input use to get an idea to the amounts of various inputs that could have been saved if all the farmers were to operate at the highest technical efficiency level (Table 5). It could be seen from the table that savi sample farmers could save 26.19 per cent of land, 24.06 per cent of human labour, 14.39 per cent of bullock labour, 23.58 per cent of farmyard manure, 23.80 per cent of seeds and 13.85 per cent of fertilizer, if they enhance their efficiency to the highest level of technical efficiency among their group. In other words, savi sample farmers could produce 6.12 quintals of savi equivalent output against present 4.41 quintals by using the existing level of inputs had they operated at the highest level of technical efficiency. Similar results were expressed by Verma (2002) in his study on economics of production, resource use efficiency and constraints.

Table 5 Actual and frontier use of resources and output in savi production per farm

Particulars	Units	Actual	Frontier	Difference (%)
Area	Hectare	1.06	0.84	26.19
Human labor	Man days	24.65	19.87	24.06
Bullock labour	Pair days	6.12	5.35	14.39
FYM	Cart loads	2.62	2.12	23.58
Seed	Kgs	4.89	3.95	23.80
Fertilizer	Kgs	44.13	38.76	13.85
Output	Qtls	4.41	6.12	-38.78

The average allocative efficiency and economic efficiency of savi production revealed that allocative efficiency was 41.35 per cent for savi sample farmers thus the economic efficiency was 25.82 per cent and the technical efficiency of these farmers was 62.45 per cent (Table 6). The quantities of different inputs required for the farmers to produce the existing level of output at the highest level of technical efficiency were called as frontier level of inputs. The use of resources by savi sample farmers revealed a greater degree of inefficiency. In other words, farmers could achieve existing level of production by using 26.19, 24.06, 14.39, 23.58, 23.80 and 13.85 per cent of less of land, human labour, bullock labour, farm yard manure, seeds and fertilizer, respectively than the existing level of input use. So, this calls for greater attention on part of farm management specialists and extension workers to train the farmers, since these farmers are using excess quantities of inputs in production of savi than the required level to achieve the frontier level of production. Though, technical efficiency of savi producing farmers was 62.45 per cent the allocative efficiency was 41.35 per cent and thus the economic efficiency was 25.82 per cent. Hence, more concerted efforts are needed to improve efficiency in savi production (Table 7).

Table 6 Technical, allocative and economic efficiency in savi production

Particulars	Average efficiency rating (%)
Technical efficiency	62.45
Allocative efficiency	41.35
Economic efficiency	25.82

Table 7 Actual and frontier use of resources and output in navane production per farm

Particulars	Units	Actual	Frontier	Difference (%)
Area	Hectare	1.25	0.97	28.87
Human labor	Man days	26.00	21.00	23.81
Bullock labour	Pair days	7.99	6.43	24.26
FYM	Cart loads	12.44	8.56	45.33
Seed	Kgs	5.06	4.75	6.53
Fertilizer	Kgs	45.48	38.75	17.37
Output	Qtls	5.81	6.72	-15.66

Kopp measure of technical efficiency of Navane

The frontier level of input use were compared with actual levels of input use to know whether farmers were using these resources excessively, less than optimum or optimally which would help in assessing the amounts of various inputs that could have been saved or raise the input use level, if all the farmers were to operate at highest technical efficiency level. The actual and frontier use of different resources in navane production indicated that navane sample farmers could save 28.87 per cent of land, 23.81 per cent of human labour, 24.26 per cent of bullock labour, 45.33 per cent of farmyard manure, 6.53% of seeds and 17.37 per cent of fertilizer if sample farmers increase their efficiency to the highest level of technical efficiency (Table 7). In other words, navane sample farmers could produce 6.72 quintals of navane equivalent output against present 5.81 quintals by using the existing level of inputs had they operated at highest level of technical efficiency.

Table 8 Technical, allocative and economic efficiency in navane production

Particulars	Average efficiency rating (%)
Technical efficiency	70.67
Allocative efficiency	31.45
Economic efficiency	22.23

The allocative efficiency and economic efficiency achieved by the navane sample farmers revealed that technical efficiency (70.67%) and allocative efficiency (31.45%) achieved by navane sample farmers resulted in economic efficiency of 22.23 per cent. The allocative inefficiency was less than the technical inefficiency in both savi and navane production (Table 8). Sikander and Sandeep (2004) reported similar results in case of resource use efficiency and returns. The use of resources by navane sample farmers revealed a greater degree of inefficiency. Farmers could achieve present level of production on sample farms by using 28.87, 23.81, 24.26, 45.33, 6.53 and 17.37 per cent of less of land, human labour, bullock labour, farm yard manure, seeds and fertilizer, respectively than the existing level of input use. So, this calls for greater attention on part of farm management specialists and extension workers for imparting training to the navane sample farmers to achieve the frontier level of production, as results showed excessive use of various inputs in navane production than the optimum level. Technical efficiency and allocative efficiency achieved in navane production was 70.67 per cent and 31.45 per cent respectively resulting in economic efficiency of 22.23 per cent. Thus the economic efficiency of navane sample farmers was less than that of savi farmers (25.82%). Thus, improvement in efficiency in navane production through concerted efforts on part of the farm management personnel and extension agencies is the felt need for improving the productivity of these crops and income levels at the farm level.

The average technical efficiency for savi production was 62.45. About 48 per cent of savi sample farmers were found to operate at technical efficiency rating less than 60 per cent. Nearly 22 and 15 per cent of the sample farmers belonged to the 61-70 and 71-80 per cent of technical efficiency rating group, respectively. Relatively less i e only about eight and seven per cent of the savi sample farmers operated in the 81-90 per cent and more than 90 per cent of the technical efficiency rating group. The average technical efficiency level achieved by the navane sample farmers was 70.76 per cent. It could be observed from the results presented in the table that the highest proportion (35.00%) of navane growing farmers operated between 61-70 per cent technical efficiency rating group followed by less than 60 per cent technical efficiency group (31.66%), 71-80 per cent technical efficiency group, 81-90 per cent technical efficiency group and only three farmers achieved more than 90 per cent of technical efficiency in the study area. Allocative efficiency was 41.35 per cent for savi sample farmers thus the economic efficiency was 25.82 per cent as the technical efficiency of these farmers was 62.45 per cent. Technical efficiency (70.67%) and allocative efficiency (31.45%) achieved by navane sample farmers resulted in economic efficiency of 22.23 per cent. The allocative inefficiency was less than the technical inefficiency in both savi and navane production. It is estimated that of the average quantity produced by the savi and navane farmers, around 68 and 78 per cent respectively of the produce was marketable surplus after considering the requirements for various purposes.

LITERATURE CITED

Kumar L R, Srinivas K and Singh S R K. 2005. Technical efficiency of rice farms under irrigated conditions of North-West Himalayan region: A non parametric approach, *Indian Journal Agricultural Economics* **60**(3): 483-493.

Mythili G and Shanmugam K R. 2000. Technical efficiency of rice growers in Tamil Nadu: A case study based on panel data, *Indian Journal Agricultural Economics* **55**(1): 15-25.

Nagaraj T and Khan H S S. 1998. Resource use efficiency in various crops under different cropping system in Tungabhadra Command Area (Karnataka). *Agricultural Situation in India* **4**(2*)*: 135-139.

Neelappa. 2002. Technical and allocative efficiency of paddy production in TBP area- An economic analysis. *M. Sc. (Agriculture) Thesis,* University of Agricultural Sciences, Dharwad, Karnataka.

Reddy A R and Sen C. 2004. Technical inefficiency in rice production and its relationship with farm specific socio-economic characteristics, *Indian Journal Agricultural Economics* **59**(2): 259-267.

Sikander and Sandeep. 2004. Resource use efficiency and returns from selected food grain crops of Himachal Pradesh, *Agricultural Situation in India* **59**(7): 461-466.

Verma A R. 2002. Economics of production, resource use efficiency and constraints: A case study of onion in Shajpur district of Madhya Pradesh. *The Bihar Journal of Agricultural Marketing* **10**(4): 429-439.